Exposure Experiment, South Pole

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The scope of this project is to directly detect and quantify the production rate of atmospheric ^{14}C. Carbon-14 is not only used for dating organic materials, it can also be used as a tracer of OH chemistry (in the form of ^{14}CO). In the latter case, if the inventory of ^{14}CO is measured and the production rate known, then the sink rate, which is oxidation by OH, can be calculated. Although cascade calculations have constrained the ^{14}CO production rate to ±20%, it is of interest to measure this rate directly.

^{14}CO is produced from the reaction:

$$^{14}N + n \rightarrow {}^{14}C + p$$

which is immediately followed by

$$^{14}C + O_2 \rightarrow {}^{14}CO + O \text{ (>90\% yield).}$$

The methodology takes advantage of gas handling techniques previously developed by these authors. A known amount of CO carrier gas was mixed in with zero air and compressed into a suite of cylinders, some of which were placed 1 m above the surface at SPO. There they sat, exposed to incoming cosmic rays. The cylinders were removed about 11 months later and brought back to the isotope laboratory in New Zealand where the CO was extracted and measured for ^{14}C content at Lawrence Livermore's Center for Accelerator Mass Spectrometry. During the same period, cylinders were exposed at Scott Base, on Mount Cook, New Zealand, and at various heights on the Boulder Atmospheric Observatory tower in Colorado. The latter was to constrain the surface effect that is known to cause an increase in the thermal neutron flux for a distance of about 150 m.

Monte Carlo simulations are currently being performed at LLNL to estimate any effects from the mass of the cylinders used as well as the ground effect. These simulations indicate that the effect from the cylinders is small. The experimental results are still being analyzed, and preliminary analyses show that the amounts of ^{14}C produced at the South Pole would be easily detectable for an exposure time of about 6 months. To our knowledge, this is the second time direct ^{14}C detection was achieved and the first time a ground effect was accounted for by direct measurement. This is an ongoing cooperative project.